12 METER MILLIMETER WAVE TELESCOPE
MEMO No. 246

National Radio Astronomy Observatory
Tucson, Arizona
June 12, 1989

MEMORANDUM

To: 12 m Observers

From: P. R. Jewell

Subject: Telescope Pointing Accuracy

Those of you who have visited the telescope lately have doubtlessly noticed that the telescope pointing characteristics are erratic. The pointing accuracy of the 12 m has never been as good as we would like, but the quality seems to have actually degraded this observing season. The observatory staff is acutely aware of this problem and is working hard to improve the situation. We have some promising ideas as to what the problems are and have some fairly extensive programs underway that should lead to better pointing. Unfortunately, most of these involve quite a bit of work and won't be ready before the 1989 Fall observing season. I will summarize here what we know about the pointing and what we are doing to improve it.

The worst effect is non-repeatable pointing measurements from day to day. In addition, we also have rising and setting hysteresis effects. The most likely candidates for these problems are

1. Shifts in the telescope apex caused by mechanical and thermally-induced movements of the feedlegs.

2. Poor mechanical tolerances in the focus (Sterling) mount owing to its old design and manufacture (~1967).

3. "Run-out" and roughness in the main azimuth bearing.

Here is what we are doing about it:

o Based on measurements with our laser/quadrant detector, we know that the apex exhibits a hysteresis loop in its position as the telescope is driven from high to low elevation and back again. It also shifts in the horizontal (X) direction when the telescope is tipped over, when only a sag in the vertical (Y) position is expected. Finally, its position seems to show considerable scatter as measurements are made over time.

  The first two problems are probably caused by uneven tension between the support guy wires and by slippage at the feedleg moorings. This summer, we will carefully re-tension the guy wires and will weld the plates where the feedlegs join the backup structure. Some of the scatter effect is probably caused by thermal distortion. To monitor and correct for this problem, we are installing a laser / quadrant detector system. This device consists of a laser that shines up from the telescope vertex to a quadrant detector sensor fixed to the apex. It measures displacements of the apex in the X and Y direction.

- We are constructing a new focus-translation (Sterling) mount that is scheduled for completion by the end of the summer. It will have X, Y, and Z translation and will be machined to the tolerances required for observations in the 850 μm band. The electronics for positioning the mount and for nutating the subreflector will be repackaged. The electronics will be completely redesigned on a time scale of about 1 year.

- We are installing two pairs of precision inclinometers (tiltmeters) at the top of each elevation yoke arm. These instruments will measure tilts in the azimuth bearing and flexure in the yokes. We expect to be able to correct the telescope pointing for unpredicted tilts in real-time. We hope to have this system operational by the fall.

- We are also installing a system to read and record feedleg and backup structure temperatures in the computer so that we can monitor uneven temperatures across the structure that may be causing thermal distortions. In addition, we are preparing the digital weather station that will allow more accurate monitoring of atmospheric refraction. The temperature monitors should be done by the end of the summer and the weather station by mid-year.

- The final component of our pointing improvement program is the further development of the optical pointing/guiding system. This system has already been extremely valuable in diagnosing our pointing problems. For example, it was used to conclusively demonstrate the rising/setting hysteresis effect. In addition, it has shown that the pointing is actually uniform and predictable over a time span of a few hours, but degrades on a period of a few days. With this system, we can obtain as many pointing measurements in 2 hours as we can in 2 days of radio pointing.

  To improve the sensitivity this system, we will be installing a larger telescope this summer, and to automate the data acquisition, we will be adding a digital frame grabber. These enhancements should make the optical telescope easier to use on a routine, every-day basis and will offer the possibility of an eventual automatic offset guiding system.

We ask for your patience while we develop these new instruments. We hope that the pointing will be considerably better next observing season. For now, keep doing those five-points!

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